

SUPPORT FOR THE AMENDMENTS

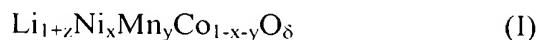
Claim 1 has been amended for clarity. The original claims have been amended to remove improper multiple claim dependencies. Newly-added Claims 10-19 are supported by the specification, especially pages 22. No new matter is believed to have been added to the present application by the amendments submitted above.

REMARKS

Claims 1-19 are pending. Favorable reconsideration is respectfully requested.

As discussed in the specification, the Inventors of the present application have discovered that a layered lithium-nickel-manganese-cobalt composite oxide having a specified composition having a volume resistivity of a specified value and a relatively low carbon content is effective for use as a positive-electrode material for lithium secondary battery. See the Background Art section of the specification.

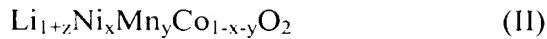
Thus, the present invention relates to a powder of a layered lithium-nickel-manganese-cobalt composite oxide which is for use as a positive-electrode material for lithium secondary battery, characterized by having a composition represented by the following formula (I), having a volume resistivity of $5 \times 10^5 \Omega \cdot \text{cm}$ or lower in the state of being compacted at a pressure of 40 MPa, and having a value of C/S, wherein C is the concentration of carbon contained therein (% by weight) and S is the BET specific surface area thereof (m^2/g), of 0.025 or smaller:



(where $0 < z \leq 0.91$, $0.1 \leq x \leq 0.55$, $0.20 \leq y \leq 0.90$, $0.50 \leq x+y \leq 1$, and $1.9 \leq \delta \leq 3$).

See Claim 1.

The present invention also relates to a powder of a layered lithium-nickel-manganese-cobalt composite oxide which is for use as a positive-electrode material for lithium secondary battery, characterized by having a composition represented by the following formula (II), having a volume resistivity of $5 \times 10^5 \Omega \cdot \text{cm}$ or lower in the state of being compacted at a pressure of 40 MPa, and having a value of C/S, wherein C is the concentration of carbon contained therein (% by weight) and S is the BET specific surface area thereof (m^2/g), of 0.025 or smaller:



(where $0 < z \leq 0.15$, $0.20 \leq x \leq 0.55$, $0.20 \leq y \leq 0.55$, and $0.50 \leq x+y \leq 1$).

See Claim 2.

One important feature provided by the present invention is that the powder of a layered lithium-nickel-manganese-cobalt composite oxide enables a cost reduction and a higher level of safety while at the same time providing improved battery performance. See paragraph [0009] of the specification (paragraph citations refer to U.S. application publication No. 2007/0202405 A1). These features have been accomplished by the Inventors' recognition that by regulating a layered lithium-nickel-manganese-cobalt composite oxide having a composition in a limited range so as to have a volume resistivity which is not higher than a specified value and a considerably reduced carbon content. See paragraph [0013] of the specification.

The Examples and the Comparative Examples described in the present specification demonstrate the non-obviousness of the claimed invention.

In Comparative Example 1, since the amount of lithium was too large, unreacted lithium was apt to remain as a carbonate. It is presumed that lithium carbonate is present on the surface of and at grain boundaries of the positive electrode active material. The composite oxide hence has a large value of CIS and the battery has low initial charge/discharge capacities,

In Comparative Example 2, since the amount of lithium was too small, the composite oxide has low electrical conductivity and the battery has high low-temperature resistance.

In Comparative Example 3, the nickel-manganese-cobalt powder to be mixed with lithium was prepared by the coprecipitation method and having a small BET specific surface area. The powder hence had low reactivity with lithium during calcination and unreacted lithium remained as a carbonate. The composite oxide hence has a large value of CIS and the battery has high low-temperature resistance.

In Comparative Example 4, since the lithium amount was too large, unreacted lithium was apt to remain as a carbonate. It is presumed that lithium carbonate is present on the surface of and at grain boundaries of the positive electrode active material. The composite oxide hence has a large value of CIS and the battery has a low initial charge/discharge capacity and high low-temperature resistance.

In contrast, by using the layered lithium-nickel-manganese-cobalt composite oxide powder satisfying the specific values of volume resistivity and CIS as set forth in Claim 1 as a positive-electrode material, lithium secondary batteries are provided which have a satisfactory performance balance with high capacity and excellent low-temperature output characteristics.

The rejections of the claims under 35 U.S.C. §103(a) over Hosoya in view of Hampden-Smith, and further in view of Shizuka, are respectfully traversed. The cited references fail to suggest the claimed layered lithium-nickel-manganese-cobalt composite oxide.

Hosoya discloses a cathode active material, which includes a lithium-transition metal composite oxide. See the Abstract and paragraph [0043] at page 3. Hosoya discloses the mere mixing of raw materials, and does not define the volume resistivity, the carbon content C, the BET specific surface area S, or the ratio C/S thereof. In addition, Hosoya do not perform an improvement of reactivity at calcination by a selection of the raw materials, a

degree of pulverization of raw material, achieving a higher specific surface area of raw materials, or a degree of mixing raw materials.

Hampden-Smith does not disclose a layered lithium-nickel-manganese-cobalt composite oxide. In Hampden-Smith, carbon is supplementarily used after dispersion. In fact, the discussion of carbon in this reference relates to the support upon which the composite electrocatalyst particles are dispersed, and not to the carbon content of the composite. Thus, the carbon in Hampden-Smith is not contained in composite oxide, and the material described in that reference is different from the powder of a layered lithium-nickel-manganese-cobalt composite oxide of the present invention.

Shizuka has been cited with respect to the subject matter of dependent Claim 5. This reference fails to remedy the deficiencies of Hosoya and Hampden-Smith discussed above.

In view of the foregoing, the combinations of Hosoya in view of Hampden-Smith and further in view of Shizuka fail to suggest the claimed layered lithium-nickel-manganese-cobalt composite oxide. Accordingly, the subject matter of the pending claims is not obvious over those references. Withdrawal of these grounds of rejection is respectfully requested.

The rejection of the claims under 35 U.S.C. §112, second paragraph, is respectfully traversed.

In the present specification, the present specification contains the following disclosure regarding the BET specific surface area:

[0040] The term CIS value means the concentration of carbon contained in the powder of a layered lithium-nickel-manganese-cobalt composite oxide per unit specific surface area. Namely, the carbon concentration C in the powder of a layered lithium-nickel-manganese-cobalt composite oxide depends on the specific surface area S of the powder. Because of this, when samples differing in specific surface area are to be properly compared, it is necessary to convert into concentrations per unit specific surface area before the comparison. The value of CIS can be calculated from the carbon content and specific surface area of the layered lithium-

nickel-manganese-cobalt composite oxide powder. In the invention, the value of CIS Is determined from the values of these properties obtained by the respective measuring methods which will be shown in the Examples given later. Namely, in the invention, the concentration of carbon C contained in a powder of a layered lithium-nickel-manganese-cobalt composite oxide is determined by infrared spectroscopy after calcination in an oxygen stream (high-frequency heating oven) as will be described later. The specific surface area of a powder of a layered lithium-nickel-manganese-cobalt composite oxide is measured with a known apparatus for measuring the BET specific surface areas of powders. Specifically, nitrogen and helium are used as the gas to be adsorbed and a carrier gas, respectively, to conduct a SET one-point measurement by the continuous flow method. First, a powder sample is heated/degassed at a temperature of 150°C with a mixed gas composed of the gas to be adsorbed and the carrier gas. Subsequently, the sample is cooled to the liquid-nitrogen temperature to cause it to adsorb the mixed gas. This sample is heated to room temperature with water to absorb the nitrogen gas adsorbed. The amount of the nitrogen gas thus desorbed is determined with a thermal conductivity detector. The specific surface area of the sample is calculated from this nitrogen gas amount. [Emphasis added.]

Thus, it is apparent that the BET specific surface area refers to the specific surface area of layered lithium-nickel-manganese-cobalt composite oxide. In view of the foregoing, the claims are definite within the meaning of 35 U.S.C. §112, second paragraph. Withdrawal of this ground of rejection is respectfully requested.

Applicants submit that the present application is in condition for allowance. Early notice to this effect is earnestly solicited.

Respectfully submitted,

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